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The comparative analysis of magnetic resonance imaging and arthroscopy of the temporomandibular joints

Włodzimierz Chmielewski[1], Hubert Wanyura[2], Zygmunt Stopa[2], Marek Gołębiowski[1]

[1] I Department of Clinical Radiology, Medical University in Warsaw, Poland
[2] I Clinic of Maxillofacial Surgery, Dental Institute, Medical University in Warsaw, Poland

Author's address: Włodzimierz Chmielewski, Department of Clinical Radiology, Medical University in Warsaw, 02-004 Warszawa, Chałubińskiego 5, e-mail: wlodekch@hotmail.com

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Summary

Background: The aim of the study was to correlate arthroscopic and MRI image of temporomandibular joints (TMJ) dysfunction on the clinical basis.

Material/Methods: The study sample comprised 44 patients. All subjects underwent bilateral MRI and unilateral arthroscopy of TMJ to evaluate disc structure, position and function, bone structure abnormalities, joint effusion localization and entity according to Wilkes classification.

Results: In 31 patients (70,5%) MRI allowed diagnosing the morphological and functional changes with the arthroscopic confidence. In 13 (29,5%) cases the differences between both images were noted. The stage of the disease was over- or underestimated at one grade level.

Conclusions: The present study contributes to an improved understanding of TMJ changes in MRI. The MRI analysis of craniomandibular disorders is extremely helpful as the primary imaging preceding arthroscopy.

Key words: magnetic resonance imaging • temporomandibular joint dysfunction

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Background

Malfunctions and morphological changes within the temporomandibular joints (TMJ) frequently cause articular dysfunction and troubles related with it. Until now the imaging diagnostics has been based on standard radiological assessment and pantomographic examination or computed tomography, rarely – on arthrography. Wider application of guided diagnostics using the magnetic resonance (MR) enabled non-invasive recognition of early stage of temporomandibular disorder (TMD) and gradation of more advanced stages. It gives the possibility of better therapeutic qualification, including definition of indications for TMJ arthroscopy (diagnostic and, possibly, therapeutic).

Aim of the study

The aim of this study was to comparatively analyze the image of temporomandibular joint (TMJ) obtained from the MR examination with the results of direct arthroscopic assessment of the inside of the joint.

Materials and methods

The study material comprised the results of MR and arthroscopic examinations of temporomandibular joints in 44 patients examined in years 1998–2004 at Temporomandibular Joints Arthroscopy Centre (TJAC) of the I Clinic of Maxillofacial Surgery and I Department of Clinical Radiology of Medical University of Warsaw. The main clinical symptoms leading to the performed diagnostics included TMJ pains radiating to face, neck or head, leaping, clicking, and cracking within the joint, disordered moves of the mandible and plugging and buzzing sensation in the ears. Age of patients varied from 18 to 71 years (mean age 37.9). Among them 40 were female and only 4 male.

Prior to arthroscopy, all patients were examined following the schema valid at the TJAC which, apart from clinical

examination, also includes the MR of temporomandibular joints. Analysis of the data acquired from clinical and imaging examination allowed qualification to one of the clinico-etiological groups. Next, all patients underwent diagnostic-therapeutic arthroscopy. In 23 patients it was performed on the right TMJ and in 21 patients on the left TMJ.

MR examination of the TMJ

The MR examination of temporomandibular joints was performed with VISART device produced by Toshiba (1.5 T), using the surface transceiver coil, with the use of routine spin-echo sequences (SE, FSE). In all patients the temporomandibular joints were shown in oblique sagittal planes, coresponding to each joint's own sagittal plane, acquiring T1-weighted, T2-weighted and proton density (PD) images with slice thickness of 3 mm. The cortical layer of mandibular condyle and condylar fossa is characterized by low signal intensity, what is conditioned by short T2 relaxation time – similarly to other parts of the skeleton. Short T1 relaxation time of adipose marrow of the neck and articular tubercle causes intensive signal within it. Articular surfaces are covered with thick, fibrous connective tissue of short T2 relaxation time, instead of cartilage typical for other joints. As a consequence, it is impossible to differentiate the cortical layer from fibrous articular tissue as both show low signal intensity.

Similarly, the articular disc which is a fibro-cartilaginous structure built of proteoglican-rich fibrous tissue is characterized by low-signal in all spin-echo images; it is best visualized on PD images. T1-weighted images (TR – 450 ms, TE – 15 ms) enabled assessment of osseous structures of the joint, ligaments and muscles. T2-weighted images (TR – 4000 ms, TE – 120 ms) allowed precise evaluation of presence, intensity and location of exudate within articular cavities. The PD images (TR – 2800 ms, TE – 12 ms) which optimally visualize the disc during mouth opening, enable assessment of both – the morphology and mobility of the disc. Moreover, in all cases the examination was also performed in frontal plane (T1-weighted images) owing to which comparative analysis of both joints was possible.

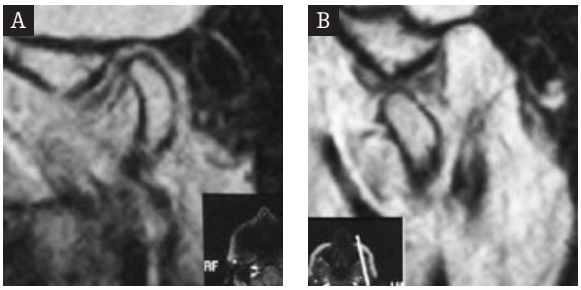

Figure 1. MRI of the TMJ. Mild anterior disc displacement with reduction during the jaw opening phase. I° in Wilkes score.

Morphological changes of articular structures and the motion disorders of the articular disc observed in MR examinations were evaluated and classified with the use of 5-grade classification designed by Wilkes [1] (table 1).

Temporomandibular joint examination with the use of arthroscopy

The diagnostic arthroscopy of TMJ was performed in general anesthesia. For assessment of the intra-articular elements we used optics with diameter of 2.4 mm and 30° angle of view, connected directly to the camera was used. The image observed on the display was recorded on VHS tape and were obtined with color printer selected shots which confirmed pathology inside the TMJ [2, 3].

The arthroscope was used to visually evaluate particular parts of the inside of joint (posterior band, articular disc, articular surface of temporal bone, synovial membrane). In order to analyze the dynamics of various parts of the TMJ structure attendants appropriately removed the mandible. The end of arthroscopy 1ml of Depo-Medrol was administrated into the joint, skin was sutured and secured with pressure dressing.

Table 1. The Wilkes classification of intra-articular disorders (modified).

	Stages of intra-articular morphological changes				
Type of examination	I stage (early)	II stage (early/ middle)	III stage (middle)	IV stage (middle/ late)	V stage (late)
MR examination	Mild anterior disc displacement, clear anatomical contours of the articular disc.	Anterior disc displacement. Thinned posterior band, early deformation of the disc. Mild articular exudate	Locked anterior disc displacement, with deformations, (thinned posterior band of the disc), articular exudate	Escalation of middle stage changes	Locked anterior disc displacement, disc perforations. Massive deformation of the disc and bones
Arthroscopy	Normal TMJ anatomy, mild anterior disc displacement mild clickings during passive movements of the mandible	Anterior displacement and deformation of the disc (thinned posterior edge), normal image of articular areas	Visible deformation of the disc with displacement small adhesions (posterior, anterior, lateral recess), no lesions in bone structures	Escalation of middle stage changes, degenerative and generative lesions of bones on both articular surfaces (osteophites, multiple adhesions), no disc or band perforation	Advanced degenerative lesions of disc and bones, perforations of the posterior band, articular erosions, multifocal adhesions adequate to degenerative lesions (flattened mandibular head, anvil-shaped condylar process, osteophytes, subcortical cysts)

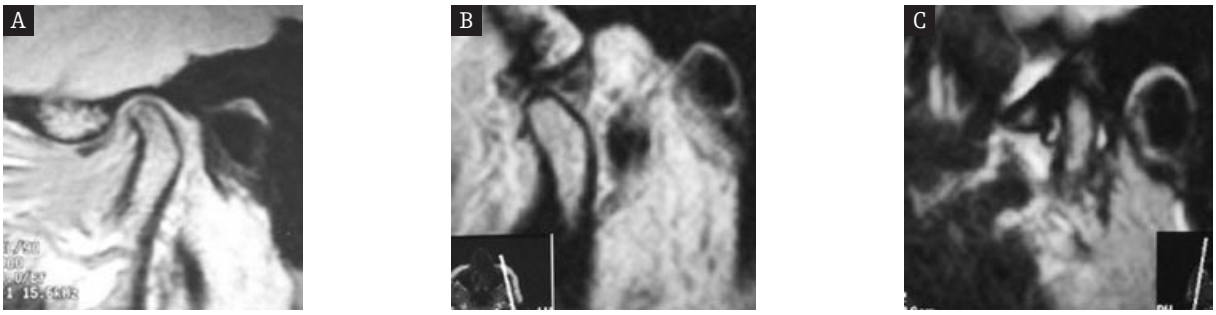

Figure 2. MRI of the TMJ. Mild anterior disc displacement with the reduction during opening. Thinned posterior band. Mild articular exudate. II° in Wilkes score.

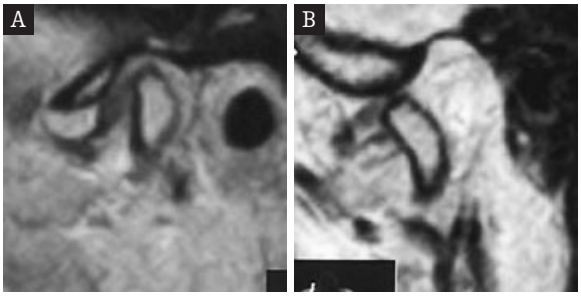

Figure 3. MRI of the TMJ. Locked anterior disc displacement . III° in Wilkes score.

After precise arthroscopic analysis of the inside of TMJ, i.e. the structure and mobility of its particular parts, the patients were qualified to one of four clinico-etiological groups and then the obtained results were compared with the classification suggested by Wilkes. His scale gradates functional disorders and intra-articular morphological lesions in imaging examinations and arthroscopy. In this study we only used the part of classification which concerns intra-articular morphological changes in both of the analyzed methods. Relations between morphological changes and clinico-etiopathological groups were described in other papers by the authors [4, 5].

Results

The MR examination of TMJ enabled recognition of lesions typical for the Ist stage according to Wilkes (fig. 1a, b) in 7/44 of cases. All exams in this group showed mild anterior disc displacement reduced in phase of mouth opening. Analogical lesions together with accompanying mild exudate in the joint and early morphological changes of the disc (mild deformation of the disc, thinned posterior band) concerned 12/44 of cases. Such patients were qualified as the IInd according to Wilkes (fig. 2a, b). In 20/44 of patients we observed anterior disc displacement locked during mandible opening and exudate in the joint with mild disc deformation. Structural changes of the osseous parts of the joint were insignificant in those cases. According to Wilkes, the cases represented the IIIrd group (fig. 3a, b). Locked articular disc and related structural changes of the head of mandible (flattening, osteophitosis), as well as posterior lesions in the marrow (3 patients) were observed in 4/44 patients, what qualified the patients to the IVth group according to Wilkes (fig. 4a, b). One of the 44 patients showed considerable thickening of the soft parts of articular cavity and geode in mandibular head (Vth stage according to Wilkes) (fig. 5).

Arthroscopy

The first group (Ist stage according to Wilkes) comprised 4 patients in whom the arthroscopy showed normal appearance of articular surfaces and, apart from mild anterior displacement, normally located and mobile articular disc (fig. 1a, b). The second group (IInd stage according to Wilkes) consisted of 15 patients – 14 women and 1 man. The arthroscopic image showed normal appearance of articular surfaces, mild deformation of the posterior part of the disc and its displacement without locking (fig. 2a, b).

The third group (IIIrd stage according to Wilkes) included 16 patients (15 women, 1 man). They were qualified to the group due to gross deformation of the disc with displacement and blocking. In 11 of them small adhesions

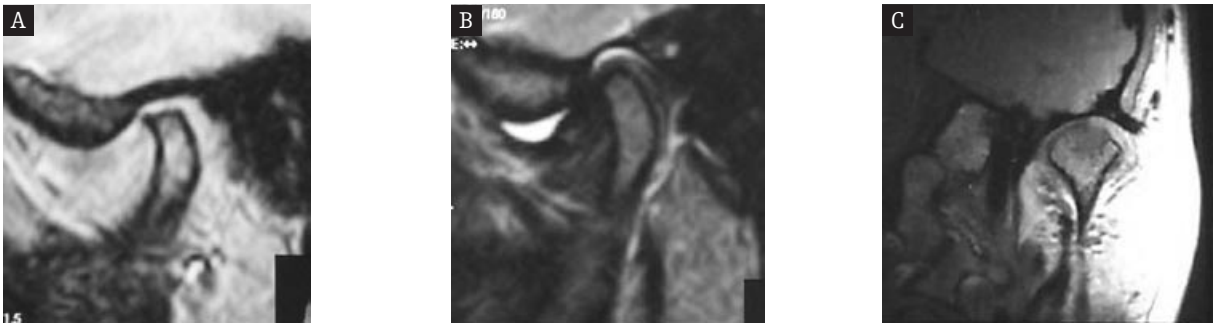

Figure 4. MRI of the TMJ. Locked anterior disc displacement. Flattening of mandible head, osteophytes (**A**). Exudate in the articular cavity (**B**). Myelodegenerative changes (**C**). IV° in Wilkes score.

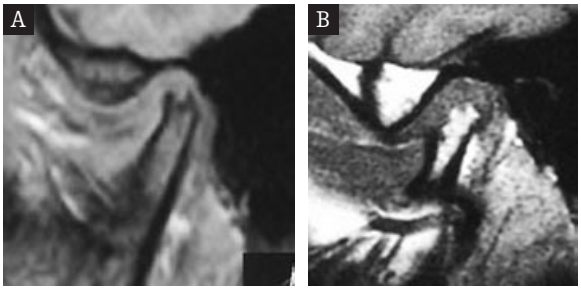

Figure 5. MRI of TMJ. Geodes in mandible head (**A**). Both articular compartments are filled with solid tissue (**B**) V° in Wilkes score.

were found in anterior and posterior recess. No macroscopic changes were seen on articular surfaces (fig. 3a, b). The fourth group (IVth stage according to Wilkes) comprised 8 patients in whom the arthroscopy showed multiple adhesions in anterior and posterior recess, deformation of articular disc and articular areas. In 4 of them singular oseophites were observed. Articular disc in these patients was displaced and locked (fig. 4a, b). Only one patient was qualified to the fifth group (Vth stage according to Wilkes). The patient presented uneven articular surfaces with osteophites, perforation of the disc and massive adhesions filling up the inside of temporomandibular joint (fig. 5a, b). Morphological assessment of the inside of the temporomandibular joint in arthroscopy allowed classification of the degree of advancement of changes within the joint with the use of the part of Wilkes' classification which concerns arthroscopy. Analogically, in order to evaluate the MR exams, patients were divided into 5 groups determined by the aforementioned scale: I (fig. 6 a, b), II (fig. 7 a, b), III (fig. 8 a, b), IV (fig. 9 a, b) and V (fig. 10 a, b).

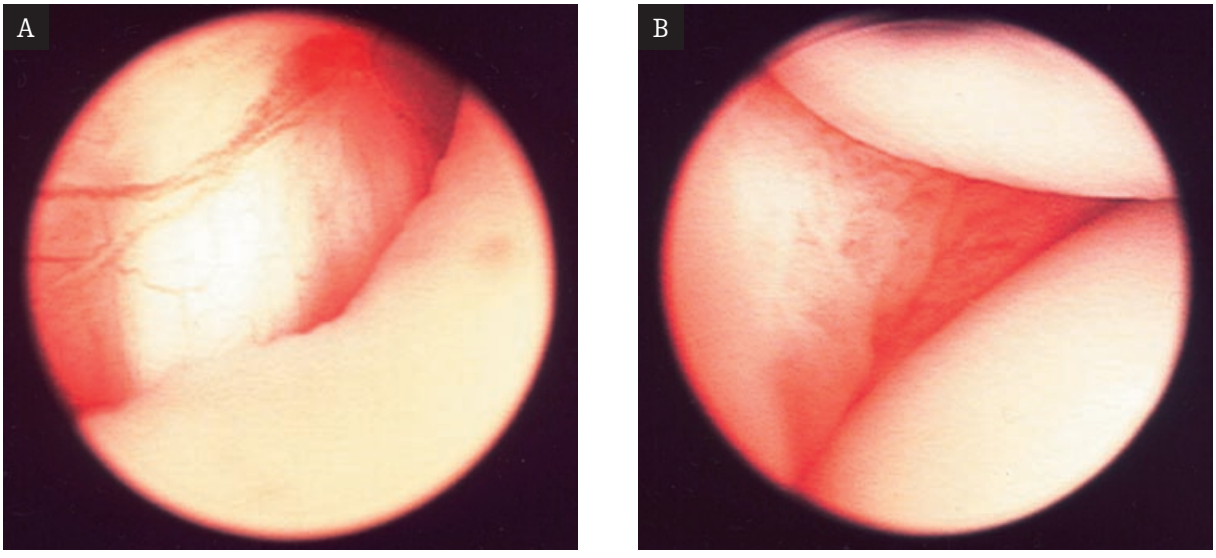

Figure 6. Arthroscopic view of the left TMJ of a19 y/o female with surgically treated myofacial pain. I° in Wilkes score. Normal image of the inside of TMJ in arthroscopy.

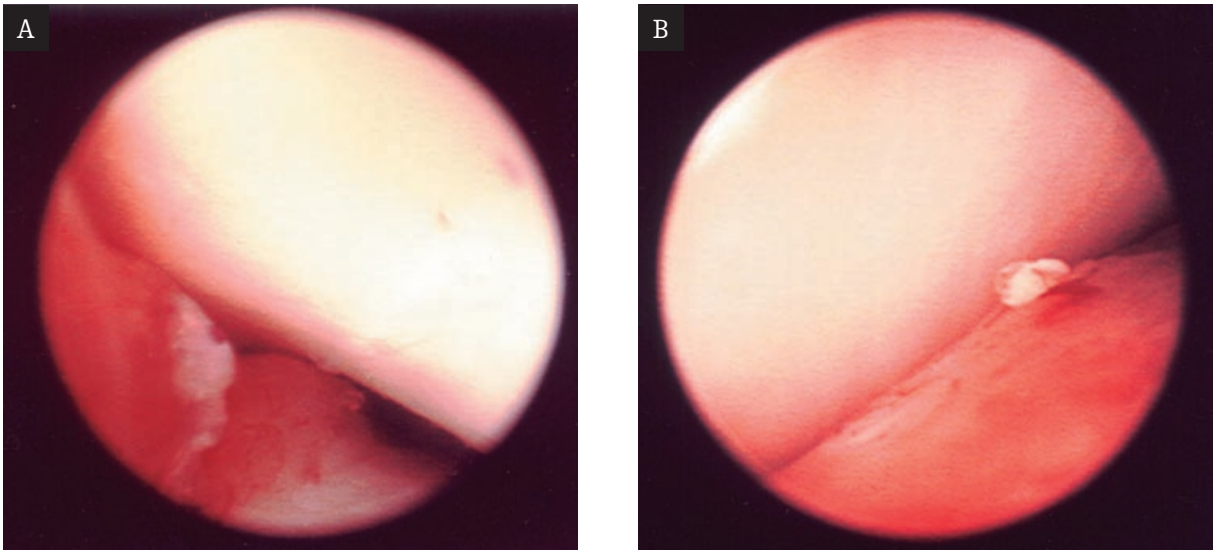

Figure 7. Arthroscopic view of the the TMJ of a 26 y/o female with surgically treated painful myofacial pain. II° in Wilkes score. Articular surface is normal. Unlocked intra-articular disc displacement. Posterior band – synovial congestion.

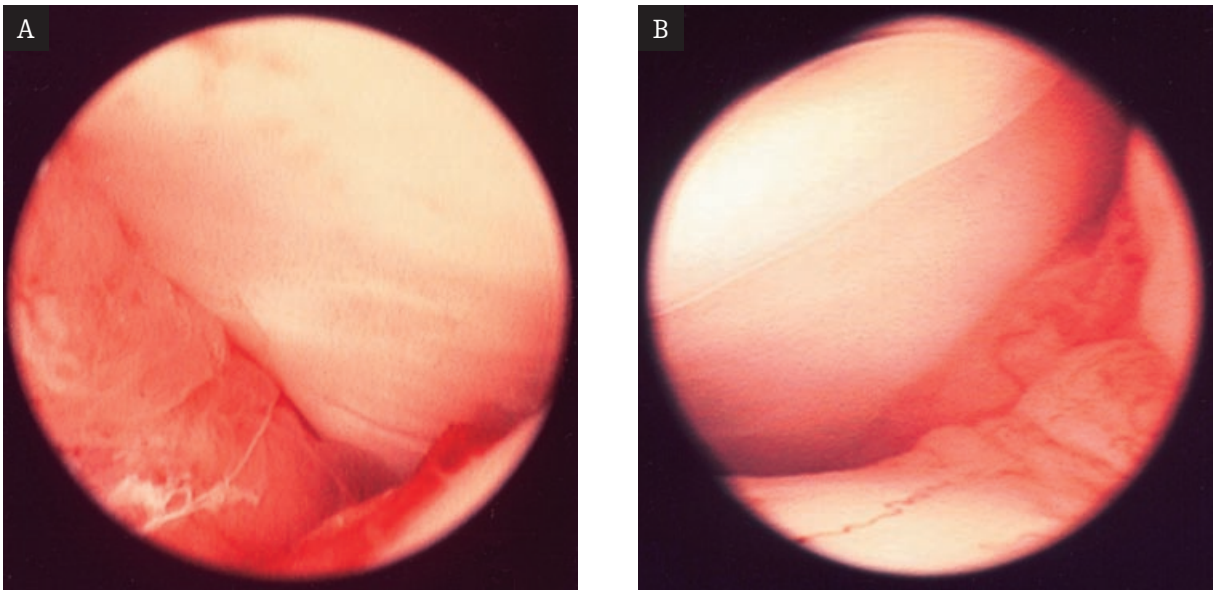

Figure 8. Arthroscopic view of the right TMJ of a 41 y/o female with surgically treated internal dysfunction. III° in Wilkes score. No pathological changes in articular surface. Locked intra-articular disc displacement. Several adhesions in posterior and anterior recesses. Intensive synovial congestion.

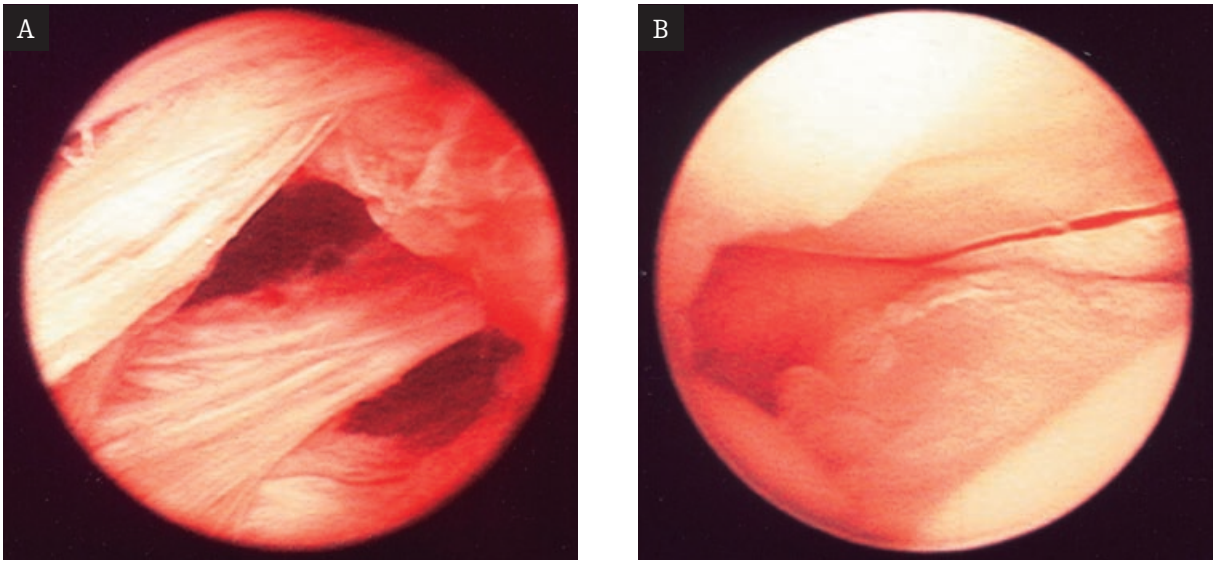

Figure 9. Arthroscopic picture of the left TMJ 51 y/o female with surgically treated degenerative changes. IV° in Wilkes score. Multiple adhesions in both recesses. Deformation and displacement of intra-articular disc.

In 31 patients (70.5%) the arthroscopic examination corroborated the degree of advancement of the disease recognized in MR examination (according to Wilkes scale). In 13 other patients (29.5%) there were discrepancies between the level of advancement of the disease stated in MR and arthroscopy. Three out of seven patients with the Ist stage of disease stated in MR examination, were classified to the IInd group during arthroscopy. Three others with the IInd stage stated in MR were arthroscopically recognized as the IIIrd stage. Four other patients (9.1%) who were classified to the IVth stage after arthroscopy were diagnosed as the IIIrd stage in MR performed before the operation. The 3 remaining patients with IIIrd stage recognized during MR examination were classified as the IInd during arthroscopy.

Discussion

The MR examination of the joints is a non-invasive method which enables visualization of tissue structures of the temporomandibular joint, especially the articular disc [6, 7, 8, 9]. The MR allows evaluation of morphology of the articular disc as well as its position in particular phases of the examination. Location of the articular disc in relation to mandibular head during mouth closing phase enables assessment of the degree and direction of its displacement compared to the normal state. The examination in mouth opening phase gives the possibility of evaluation of disc mobility in relation to the head of mandible and articular tubercle allowing recognition of locked disc or reduction of its displacement observed in mouth closing phase. T1 and T2-weighted images make

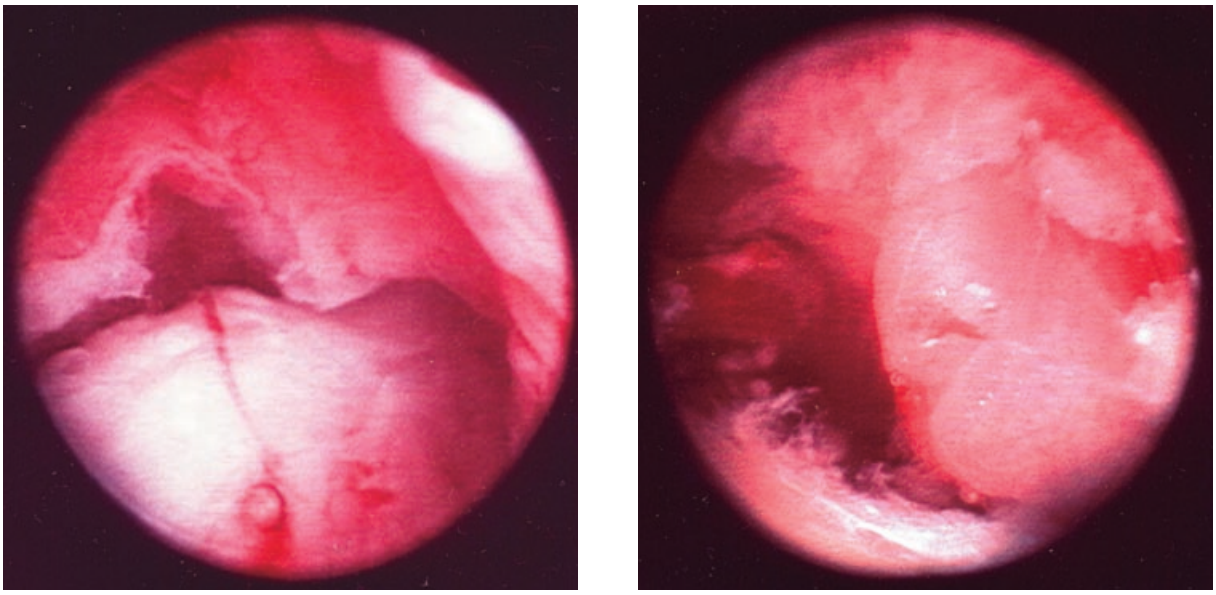

Figure 10. Arthroscopic image of the left TMJ of a56 y/o female with surgically treated myofacial pain dysfunction. V° in Wilkes score. Perforation and deformation of articular disc. Massive intra-articular adhesions. Deformation of articular surfaces.

it possible to accurately show the osseous parts of the joint, while precise evaluation of the exudate in articular cavities is possible on T2-weighted images.

Arthroscopy is a relatively new diagnostic and therapeutic technique applied to patients with TMJ disorders [10, 11]. Apart from a few exceptions, the procedure concerns mainly the upper level of the joint [3, 6, 12, 13]. Position of the disc during arthroscopy is evaluated indirectly – it is characterized by: the disc covering mandibular head, presence of vessels in the posterior band, changes in tissues in the back of the articular disc [14]. During the movement of opening the mouth the articular disc can move onto the head of mandible what is a clear sign of previous displacement of the disc without blocking. The evaluation of lower level of the TMJ is possible in patients with perforation of the articular disc [6, 12, 13].

Most authors agree on the efficacy of the MR examination in evaluation of the position of the articular disc [7, 8, 9, 15, 16]. The study of Rao et al evaluated the correlation between MR scan, arthrography and arthroscopy in patients with TMJ disorders [8]. They proved 92% of agreement between the position of the disc in MR scan and arthroscopy examination. The position and mobility of articular disc is the basic element in the MR exam which enables classification of the degree of intensity of changes in TMJ with the use of scale developed by Wilkes. In our material the agreement of MR in evaluation of the position and mobility of the articular disc with arthroscopy amounted to 84.5% (38 patients). In 3 cases the blocked disc was misdiagnosed, while arthroscopy showed preserved motion of the disc. In three other patients the arthroscopic examination revealed blocked articular disc while in the MR the changes were classified as the IInd stage according to Wilkes (without locking). However, it should be stressed that in all 6 cases significant motion disorders within the temporomandibular joint made the definite evaluation of disc mobility impossible. It seems that massive dysfunction of TMJ mobility practically disables classification of intra-articular disorders according to the aforementioned classification as the reason for such condition can be located outside the joint and it does not necessarily mean that there are massive adhesions inside the joint. Yet, if the motion is preserved or only partially disabled the possibility for evaluation of the mobility in MR examination amounts to almost 100%.

The MR examination does not allow a precise evaluation of range and location of intra-articular adhesions [8]. As for the analyzed material, the discrepancies between MR and arthroscopy also concerned the morphological analysis of the articular disc, what is by far the consequence of significant individual variety of such parameters as its size, shape and thickness. Variation of signal within the articular disc is a more objective sign of degenerative lesions. Degenerative changes of the disc are characterized by proliferation of collagen fibers, which causes increase of the signal intensity in MR image [7]. In 10 patients there was difference in assessment of intra-articular disorders; in MR the degree of lesions was underestimated by 1 point in Wilkes classification, while in 3 patients it was overestimated by 1 point. On the other hand, arthroscopy which gives the image of joint enlarged 20 times also gives the possibility of accurate evaluation of the number of adhesions and their location, as well as precise visualization of morphology of the articular disc [8]. Perforation of the articular disc found during arthroscopy in one of the patients was not found in MR examination, though evaluation of the degree of intra-articular disorders in this case was the same in both of the methods.

Conclusions

The MR examination of TMJ enables the evaluation of tissue structures of temporomandibular joint including the articular disc allowing correct preparation of the patient for planned TMJ arthroscopy. Owing to the direct, precise visualization of intra-articular structures the arthroscopic examination definitely completes the imaging diagnostics.

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